

# NASA TECH BRIEF

## *NASA Pasadena Office*



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### New Type of Trifunctional Alcohol

A new type of trifunctional alcohol has been synthesized from commercially available trimer acid. The trifunctional alcohol is a hydrocarbon with widely separated terminal hydroxyl groups, and it was expressly developed as a crosslinking agent for the preparation of polyurethane propellants, binders, and case liners; however, it may also be used as an additive in formulations for epoxy resins, alkyd resins, and elastomer systems which require high thermal stability.

The preferred method of synthesis involves quantitative conversion of all carboxylic acid groups in trimer acid to form a trifunctional alcohol which is free of intermediate reduction products. The starting material for synthesis is a specially hydrogenated form of the trimer acid that is prepared commercially by trimerization of C-18 fatty acid; commercially available trimer acid is hydrogenated until the iodine number of the product is 0.4 or less. The hydrogenation is performed at a temperature of about 110° to 140°C and a pressure of 12 to 14 MN/m<sup>2</sup> (1.8 to 2.0 ksi) in a hydrocarbon solvent; the catalyst consists of about 5% by weight of palladium-on-charcoal. The hydrogenated trimer acid is then esterified over a period of seven days by refluxing in a solution of ethanol and toluene; sulfuric acid is used as catalyst. Water is removed continuously by separation of the ternary azeotrope and recycling of the toluene; at the conclusion of the esterification, the acid catalyst is removed by a sodium bicarbonate wash. The trimer acid triethyl ester is a nonviscous oil with a very low carboxyl content.

About 100 g of the trimer acid triethyl ester is dissolved in 500 ml of anhydrous diethyl ether, and the resulting solution is slowly added to an agitated slurry of 300 g of lithium aluminum hydride in about one liter of anhydrous ethyl ether. Throughout the addition, the mixture is stirred by high-torque mechanical stirrers. Some of the ether refluxes immediately, indicating that chemical reaction is occurring; a solid is also formed. The resulting thick precipitate is allowed to stand overnight and then hydrolyzed by cautious addition of water. The hydrolysis is completed by addition of dilute sulfuric acid. Finally, the ether layer is separated, washed with aqueous sodium bicarbonate solution, and then with water. The ether is evaporated; there remains a liquid product which can be identified as a C-54 branched-chain alcohol with primary terminal hydroxyl groups and a functionality value of 3.0.

The molecular weight of the trifunctional alcohol is about 750. When used as a crosslinking agent, it can be readily poured, blended, and intermixed with typical propellant polyurethane materials prior to final cure. Additionally, the trifunctional alcohol is much more soluble in polyurethanes than are other commercially available lower molecular weight trifunctional glycols and triols.

#### Notes:

1. The trifunctional alcohol can also be prepared by direct, copper chromite-catalyzed hydrogenation of trimer acid triethylester at 250°C and 34.4

(continued overleaf)

kN/m<sup>2</sup> (5 ksi), but impurities such as aldehydes are apt to be present.

2. Requests for further information may be directed to:

Technology Utilization Officer  
NASA Pasadena Office  
4800 Oak Grove Drive  
Pasadena, California 91103  
Reference: 72-10553

**Patent status:**

NASA has decided not to apply for a patent.

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